Journal of Global Biosciences
Peer Reviewed, Refereed, Open-Access Journal
ISSN 2320-1355
Volume 10, Number 1, 2021, pp. 8326-8339
Website: www.mutagens.co.in
URL: www.mutagens.co.in/jgb/vol.10/01/100110.pdf

SCAN ME

Research Paper

EVALUATION OF PRETREATMENT EFFECTS ON OIL ABSORPTION AND ORGANOLEPTIC QUALITY OF POTATO FRENCH FRIES

Oli Legassa

Food Science and Nutrition Research Laboratory directorate,
Ethiopian Institute of Agricultural Research, Debre Zeit Center,
Ethiopia.

Abstract

Qualities of fried potatoes include physical and mechanical properties. Color and crispiness are the most important organoleptic quality of potato French fries which might be improved by pretreatments.This study was conducted with objective to evaluate the effects of pretreatments on oil absorption and organoleptic quality of potato French fries. Potato slices were treated with NaCl, $CaCl_2$, lemon juice and sugar at 1 and 2 %(w/v), respectively. The weight difference before and after treatment was obtained using analytical balance. The total soluble solids and pH of the solutions before and after treatment was measured by digital pocket refractometer and pH meter, respectively. For chips preparation, oil was heated for 5 minutes and then the slices were fried for 7 min. Moisture and fat content were determined in an oven and Soxtec apparatus, respectively. Sensory quality was determined using panelist. Pretreatments with NaCl and $CaCl_2$ has decreased the weight of the slices after soaking. The total soluble solids of the Solutions were slightly increased. NaCl and $CaCl_2$ had significantly decreased moisture content of the slices. The highest result was that of 2%NaCl (4.70) whereas the lowest was obtained from the control in crispiness. The samples treated with citric acid (1 and 2%) were whiter than other treatments. The lowest oil absorption was recorded from 2% NaCl (23.06). It was significantly different from other treatments except sample treated with $CaCl_2$ solutions (1 and 2%). This shows that these treatments can reduce oil absorption in addition to improving sensory quality of French fries.

Key words: *oil uptake, potato slices, citric acid, French fries, browning reaction*.

INTRODUCTION

Background and justification

Potatoes are one of the most famous product that exposed to enzymatic browning (Yıldız, 2019). This type of browning is an undesirable reaction that is responsible for

unpleasant sensory qualities (Espin *et al*., 1997). Enzymes such as polyphenol oxidase and other non-enzymatic chemical reactions (whitaker, 1997) may involved in this browning reaction.

Browning can be reduced or prevented by some pre-treatments such as reducing the pH and adding preservative chemicals (Annese *et al.,* 1997). Among these chemicals, citric acid, acetic acid, and ascorbic acids are commonly used (Whitaker *et al,* 1995). According to Abou-Zaid, (2015), pretreatments applied to potato slices can be dipping. The author used 1-3%NaCl, 0.5-2% citric acid and their mixture and found that they improved crispness and color of the potato chips. Color of potato chips is an important parameter controlled during processing together with crispness (Rosen and Hellenas, 2002).

Frying is one of the oldest unit operations in industry and at home (Pedreschi, 2012). By creating unique sensory characteristics, it makes food desirable and tasty (Cristina *et al.,* 2019). Deep fat frying is a dry cooking process that is involved of immersing food pieces in hot vegetable oils (Moyano *et al.,* 2002). According to Moreira *et al*., (1999), fried foods with low oil content can have a hard and unfavorable texture while higher oil content leads to a high-fat product that can be unattractive.

The increasing awareness of the influence of food on human health has shifted consumer preferences to healthier foods (Aschemann- Witzel and Hamm, 2010).Today, customers are looking for food products with lower oil contents that increase necessity of reducing the oil content of final products (Garmakhany *et al.,* 2014). The high oil content in fried products negatively related to consumer health, as it can lead to obesity, arterial hypertension, and coronary diseases (Sayon-Orea *et al.* 2014).

According to Garmakhany *et al., (*2012), food composition (like moisture and solid content) and pretreatments (i.e. partial drying and blanching) are important parameters in oil absorption determination. Moisture removal during frying leads to uptake of oil that equals to 35 -40% of the mass of the product(Aguilera and Gloria-Herna´ndez, 2000, Kita *et al.* 2007).To decrease this high oil absorption, pretreatment by citric acid, NaCl and calcium chloride can be used (Mestdagh *et al.,* (2007),

The improved lifestyle has increased consumption ready-to-eat products (Oms-Oliu *et al.,* 2010, Yousuf and Kumar, 2017). The necessity of potato French fries is increasing at fast rate than before especially in towns and cities. However, the oil absorption of the French fries during deep fat frying is said to be high in addition to browning problem. Therefore, the objective of this study was to evaluate the effects of different pretreatment on organoleptic quality and oil absorption capacity of potato French fries that may solve the existing problems**.**

2. Materials and methods

2.1. Raw materials

The potato sample, sunflower oil, and lemon were bought from Bishoftu super market and brought to Food science and Nutrition Laboratory of Ethiopian Institute of Agricultural Research, Debre Zeit Center.

2.2. Experimental Design

The Completely Randomized Design (CRD) was used with three replications. All solutions were prepared at 1 and 2 %(w/v) while distil water was used as a control. After removal from the treatment solutions, each of them was dipped into distil water and then 1% NaCl to have adapted French fries taste.

2.3. Samples and Pretreatment solutions preparation

Potato tubers were washed, hand peeled using stain less steel knives (Magda *et al.,* 2015). Pretreatments were carried out according to El-Bassiony *et al.,* (2015) with minor modification. Solutions of $CaCl_2$, citric acid (lemon juice) and sugar were prepared with different concentrations (1 and 2 %w/v

2.4. Methods

The weight difference of potato slices before and after soaking into the solutions were measured by analytical balance (KERN &SOHN GmbH, Ziegelel1, 72336 Balingen, Germany). The slices were removed from the solutions and the surface water removed by dry towel before putting on balance. The pH of solutions before and after soaking the slices (for 1hr) were determined by pH meter (Jen Way, 3510, Serial No. 64243, Stone, Staff, UK, ST15 OSA). The total soluble solids of the solutions before and after soaking were determined by using digital pocket refractometer (S/NO. J114512, Atago refractometer PAL-1). For frying, Sunflower oil (500ml) was placed in a fryer and heated for 5 minutes on a hot plate. Then, pretreated slices were fried for 7 min (Ismial *et al*., 2013). Moisture content was determined by drying about 5g of ground potato French fries at 105^{o}C (AACC, 1986) in an oven for overnight. The oil content of the potato French fries was determined using the Soxlet extraction apparatus with petroleum ether (AACC, 1986). About 3g of ground potato French fries weighed and extracted by petroleum ether. The final fat content was determined mass as difference in percentage.

2.5. Sensory evaluation

Sensory evaluation was conducted according to Silayo *et al*. (2003) with minor modification (using 20 randomly selected untrained panelists). The 5-point hedonic scale was used to evaluated taste, color, aroma, crispiness, and overall acceptability of the product.

2.6. Statistical test

Data were analyzed by one way-ANOVA by using Minitab 17 software and significance difference was analyzed by using the Fisher LSD Method at 95% Confidence level. Data were interpreted as mean ± standard deviation.

3. Result and Discussion

3.1. Weight change, before and after pretreatment

In the solutions used for pretreatments, some changes occurred because of osmotic process. Weight change in before and after soaking of potato slices into solutions discussed below:

Table 1: A table showing difference in weight of potato slices before and after soaking in solutions

Treatment Type	Weight difference in %	Treatment effect
NaCl 1%	+6.95	dehydration
NaCl 2%	+17.29	dehydration
Citric1%	-5.17	hydration
Citric 2%	-8.17	hydration
sugar1%	-7.47	hydration
sugar2%	-5.24	hydration
$CaCl_2$1%	+5.10	dehydration
$CaCl_2$2%	+6.24	dehydration
Water	-9.61	hydration

In the current study, the Potato slices treated with both NaCl and $CaCl_2$ (1 and 2%) were decreased in their weight. The percentage of decrement was 6.95 for 1% NaCl where it was more than double at 2% of same solution (17.29). Somewhat similar results were recorded for $CaCl_2$ at 1 and 2 % (5.10 and 6.24 respectively). The weight of samples treated with NaCl and $CaCl_2$ decreased (dehydrated). Osmotic dehydration is a process in which cellular material is immersed in a hypertonic solution (Catherine *et al.,* 2001). It received considerable attention in contemporary years for the dehydration of fruits and vegetables (Zeeshan *et al.,* 2016).

The weight of potato slices treated with water, sugar, and citric acid at 1 and 2% were increased (hydration). There are evidences that sugar is used as dehydrating agent at high concentration (up to 10 to 40%). The difference may come from difference in concentrations. According to Mokhtar *et al*., (2019), concentration is a driving force results between the bulk and the surface of the potato sample, which moves the water from the interior towards the surface. However, in this study, the result is contradicting which may be due to low concentration of the sugar solutions when compared with the sugar concentrations inside of the potato slices. The increase in weight caused by citric acid solution (1 and 2%) may be the effect of acidity that may accelerate the penetration. In general, it was identified by this research that pretreatment by NaCl and

$CaCl_2$ can reduce the water contents of potato slices that have a role in increasing the crispiness of the french fries as observed from the results of organoleptic evaluation by panelists.

3.2. The pH the Solutions before and after soaking/dipping

By definition, pH is an indicator of the active concentration of hydrogen ions in aqueous solutions (denoted by $[H^+]$) (Li *et al.,* 2016). It is an indicator of its acidity or alkalinity level.

Table 2 shows the pH of solutions before and after soaking of potato slices

Treatment Type	Before	After
NaCl 1%	7.31 ± 0.00^{abc}	7.26 ± 0.02^{ab}
NaCl 2%	7.25 ± 0.03^{bc}	7.25 ± 0.03^{ab}
Citric1%	7.24 ± 0.02^{c}	7.21 ± 0.00^{b}
citric 2%	7.09 ± 0.03^{d}	6.92 ± 0.16^{c}
sugar1%	7.31 ± 0.00^{ab}	7.36 ± 0.02^{ab}
sugar2%	7.26 ± 0.03^{a}	7.33 ± 0.03^{ab}
$CaCl_2$1%	7.30 ± 0.03^{abc}	7.32 ± 0.04^{ab}
$CaCl_2$2%	$7.31\ 0.00^{abc}$	$7.34\ \ 0.04^{ab}$
Water	7.32 ± 0.01^{abc}	7.28 ± 0.07^{ab}

Data were expressed, as mean ± SD. Values followed by the same letter are not significantly different. (p>0.05),

In before soaking solutions, the pH difference in the solutions was not significant except that of the citric acid at 1% and 2%, which were 7.24 and 7.09, respectively. This may come from the low pH of citric acid. Even though not significantly changed, there were a slight decrease for both NaCl and sugar solutions whereas the pH of $CaCl_2$ solutions were slightly increased which may be due to the high pH of $CaCl_2$ (8 to 9). The finding by Abou-Zaid (2015) has indicated that the pH of 1, and 2% of citric acid has changed pH of water (7.2) to 2.2, and 2.0, respectively. This value is in the range for normal lemon juice pH (2 to 3). However, in the current study, the decrement is not high even though it was significant statistically.

In after soaking solutions, the pH of water, NaCl, and citric acid solution was decreased. However, only the results of citric acid solutions (1 and 1%) were significantly different from control sample (7.28). According to Abou-Zaid (2015), the pH values of water and NaCl solutions were decreased from initial pH values of 7.2 and 7.1 to 6.4 and 6.3, respectively. This may be due to the lower pH of potato slices comparing with pH of mentioned solutions. The pH of potato is 6.13 to 6.27 (Abbasi *et al.,* 2011) whereas that of lemon juice is 2 to 2.45 (Sindhu and Khatkar, 2018).

3.3. Total Soluble Solid (TSS) of pretreatments solutions

Total soluble solid is amount of total soluble solid present in the known volume of solution (Bavaneethan, 2018). In the current study, the total soluble solids in solutions

used for treatments were measured before and after soaking of the potato slices. The total soluble solids of all the solutions after soaking were increased when compared with that of solutions before soaking the slices. This shows that the solutions have the power to withdraw soluble materials from the slices. The higher results recorded for samples soaked in both salts (NaCl and $CaCl_{2)}$ at 2% solutions. According to the study of Abou-Zaid (2015), a slight increment observed in the TSS contents of all solutions. This increment was from 0.1 to 0.3%. It was indicated by this author that it might be because of transferring of some components from the potato slices to soaking solutions.

Table3: A table showing the result TSS of the solution before and after soaking.

TreatmentType	TSS	
	Before	After
NaCl 1%	1.17 ±0.15^{c}	1.83±0.25^{b}
NaCl 2%	2.27 ±0.15^{a}	2.83±0.06^{a}
Citric1%	0.10 ± 0.00^{d}	0.74±0.76^{cd}
citric 2%	0.17 ±0.06^{d}	1.03±0.67^{cd}
sugar1%	2.00± 0.10^{ab}	1.33±0.06^{bc}
sugar2%	2.07 ± 0.21^{ab}	2.70±0.17^{a}
$CaCl_2$1%	1.73 ± 0.76^{b}	0.97±0.06^{cd}
$CaCl_2$2%	2.03±0.0577^{a}	2.52±0.12^{a}
Water	0.00±0.00d	0.47±0.12^{d}

Data were expressed, as mean ± SD. Values followed by the same letter are not significantly different. (p>0.05), TSS - Total Soluble solids

3.4. Moisture Content of frech fries

After frying, fat and moisture contents changed due to applied heat and water removal through evaporation caused by high temperature. The moisture contents of the french fries after pretreatments are in presented in Table 4 below.

Table 4: Moisture content of potato french fries after pretreatments

Treatment	Moisture Content
1%Nacl	1.250 ± 0.21^{d}
2%NaCL	1.130 ± 0.14^{d}
1%Citric Acid	1.82±0.07^{b}
2%Citric Acid	1.78 ± 0.16^{b}
1%sugar	1.720 ± 0.20^{bc}
2%sugar	1.4200 ± 0.09^{cd}
1%$CaCl_2$	1.43±0.04^{cd}
2%$CaCl_2$	1.18 ±0.14^{d}
Water	2.3500 ± 0.07^{a}

Data were expressed, as mean ± SD. Values followed by the same letter are not significantly different. (p>0.05),

The highest moisture content (2.35) was recorded from the control sample whereas the lowest mean (1.13) was that of 2% NaCl. The effect of pretreatments may cause this moisture reduction by removing free water from the slices through osmotic process. During soaking of the sample for 1hr, the result obtained from weight difference test has shown that the control sample had gained weight up to 9.61% whereas the samples treated in 2% NaCl had lost its original weight up to 17.29%. The increasing of moisture content for the control sample might be caused by wilting that accelerates rehydration to replace the water lost after harvesting. Low moisture content is much needed in potato French fries to have a crispy snack. Because, using such a type treatment can be a better option to produce a French fries with high preference in organoleptic quality. Moisture levels that are higher (e.g., greater than 1.5 %) may affect flavor, texture, and shelf life (Kalyani *et al.,* 2016). Because, it can be seen from this current results that pretreatment can reduce moisture contents and improves some attributes like color and crispiness of the French fries. As seen from sensory tests by panelists, the crispiness of samples scored low moisture contents were increased significantly

3.5. Fat content of frenh fries

Fat uptake and characteristics crispy texture are main quality parameters of fried potato products such as the most popular French fries (Mirzaei *et al.,* 2015). Oil uptake during frying needs to be considered during frying because the fat content of a product may also affect its flavours, odor, and general organoleptic properties (Teferi and Chala, 2019).

Table 5: Result of moisture content from French fries after pretreatments

Treatment	Fat Absorption
1%Nacl	26.74 ± 0.01^{bc}
2%NaCL	23.06 ± 0.24^{e}
1%Citric Acid	28.43 ± 0.44^{a}
2%Citric Acid	27.49 ± 0.23^{ab}
1%sug	28.55 ± 0.96^{a}
2%sug	27.64 ± 1.09^{ab}
1%$CaCl_2$	25.35 ± 0.52^{de}
2%$CaCl_2$	24.43 ± 0.62^{e}
Water	28.08 ± 0.93^{ab}

Data were expressed as mean ± SD. Values followed by the same letter are not significantly different (p>0.05).

The lowest oil absorption was scored from 2% NaCl (23.06) which also resulted a good crispiness and taste. It was significantly different from other treatments except sample treated with $CaCl_2$ solutions (1 and 2%). They were extremely different from other treatments that indicated that they might be used in decreasing of fat content in potato French fries. As shown in table 2; both NaCl and $CaCl_2$ have shown dehydration effects, which may be the cause for the improvements of the crispiness of the potato French fries. The overall acceptably results from 2% NaCl was similar with 1% NaCl that shows

using of this salt can decrease oil absorption of potato French fries without affecting its organoleptic taste. This reduction of oil absorption capacity may come from shrinkage of tissues caused by considerable water removal during soaking. This shrinkage may further continued in frying oil by reducing water left in the cell through evaporation. This shrinkage of the tissues may prevent oil not to enter into the slices.

The highest result (undesirable) was recorded from 1% citric acid (28.43) with no significant difference with distilled water (control). This may be due to rehydration caused during soaking that prevent the tissues from shrinkage and allows oil entrance in place of removed water by high temperature. French fries are primarily prepared by deep fat frying where heat is transferred and oil is absorbed by the food concurrently (Krokida *et al.,* 2001). During the deep fat frying method, oil absorbed into the food, increasing the total fat content (Parikh, 2013). The soft and moist interiors together with crispy crust are desirable characteristics of most fried foods (Mirzaei *et al.,* 2015).

According to Abou-Zaid, (2015), the oil uptake of different pretreated potato slices were observed that different citric acid pretreatments (0.5%, 1%, and 2%) had slight effect on oil uptake of fried potato. This author has also reported that NaCl (1%, 2%, and 3%) had noticeable effect on reduction of the oil uptake. This report also shows that highest reduction (31.27%) was recorded from solution of 3% NaCl. These are in agreement with those reported by Bunger *et al.,* (2003), who found that, potato strip impregnation in 3% NaCl solution per 50 min allowed obtaining French fries with lower oil content by 22%. This result was very similar with the result obtained in the current treatment by 2% NaCl (23.06). The result obtained from 3% NaCl was very similar with results recorded from $CaCl_2$ solutions. According to Tran and Chen (2013), Sugar dipping is considered as the pre-treatment of potato crisps to reduce amount of oil uptake. The relationship of Oil uptake was positively related to moisture loss (Ankur Arya, 2017). In the current study, NaCl and $CaCl_2$ solutions have decreased the moisture and oil contents of French fries. This result is in agreement with these previous researches. It can be concluded from current results that NaCl and $CaCl_2$ can be applied for pretreatment purpose to decrease moisture contents and also fat uptake of the french fries that help in increasing crispiness of French fries.

3.6. Sensory Evaluation Results

Sensory evaluation result of the potato French fries is shown in Table 6 and the effect of the pretreatments used were discussed as follows.

Appearance is the general overlook of the product. The sample soaked in the distilled water (4.2) was not significantly different from all other treatments except 1%citric acid (4.80). This difference is expected to come from panelists' error. According to Mestdagh *et al.,* (2008), appearance of the French fries treated with NaCl was improved than control. However, the current results show that the difference is not significant

Table 6: The results of sensory evaluation

Treatment	Appearance	Color	Taste	Aroma	Crispiness	Overall Acceptability
Control	4.2±0.77^{b}	4.05±0.82^{e}	4.60±0.51^{a}	4.2±0.89^{bc}	4.00±0.86^{b}	4.10±0.72^{b}
1%NaCl	4.43±0.51^{ab}	4.71±0.46^{abc}	4.62±0.59^{a}	4.47±0.46^{a}	4.33±0.66^{a}	4.52±0.68^{a}
2%NaCl	4.55±0.61^{ab}	4.10±0.72^{bc}	3.70±1.03^{bc}	4.60±0.60^{a}	4.70±0.47^{a}	4.25±0.79^{ab}
1%Citric acid	4.80±0.41^{a}	4.65±0.59^{abc}	3.55±0.99^{abc}	4.15±0.75^{b}	4.65±0.49^{a}	4.30±0.57^{ab}
2%Citric acid	4.60±0.59^{ab}	4.85±0.37^{a}	3.40 ±0.75^{bc}	3.95±0.89^{c}	4.60±0.50^{a}	4.35±0.59^{ab}
1%$CaCl_2$	4.35±0.67^{b}	4.4±0.82^{bc}	4.45±0.61^{ab}	4.3±0.66^{abc}	4.45±0.69^{a}	4.20±0.70^{ab}
2%$CaCl_2$	4.45±0.51^{ab}	4.40±0.82^{cd}	4.25±0.64^{abc}	4.55±0.69^{a}	4.70±0.47^{a}	4.00±0.79^{b}
1%sugar	4.20±0.62^{b}	4.55±0.61^{abc}	4.35±0.59^{abc}	4.35±0.67^{a}	4.45±0.51^{a}	4.25±0.64^{abc}
2%sugar	4.55±0.76^{ab}	4.70±0.47^{abc}	4.48±0.58^{ab}	4.40±0.82^{a}	4.65±0.59^{a}	4.33±0.62^{ab}

Data were expressed as mean ± SD. Values followed by the same letter are not significantly different (p>0.05).

As seen from table 6, statistical difference was found in color between the control and other treatments. The highest value was that of 2% citric acid solution (4.48) and lowest value is that of control sample (4.05). The samples treated with 1 and 2% citric acid were whiter than other treatments. The lightness of crisps color is most desirable compared to golden and reddish brown color for some consumers (Pokorny, 1999).The mixture of ascorbic acid (2%)-calcium chloride (1%) treated potato samples showed significantly higher L (lightness) values than that control and other treated samples (*.Yıldız , 2019).* The finding by Abou-Zaid (2015) has reported that the sensory results of both 0.5 and 1% citric acid solution samples were significantly different from the samples treated with distil water and 1 to 3%NaCl. Also Mestdagh *et al., (*2008) has reported that crisps blanched in water containing citric appeared to be brighter when compared to the control, although the difference was statistically not significant. These

authors have also addressed that $CaCl_2$ and NaCl did not significantly changed product color. These research evidences are similar with the current result. This treatment may help in production of white French fries to supply this product in diversified ways for consumers who like bright french fries.

Taste perception is a very important quality parameter in food preference. The highest values were that of samples treated with 1%NaCl (4.62) and distilled water (4.60). They were statistically different from treatment in 2% NaCl and 2%citric acid solutions. This may be due to absorption of the solution into the matrix of the slices. The report by Ismial *et al*., (2013) has revealed that the taste samples blanched in solution of NaCl had significantly highest. Abou-Zaid (2015) has indicated that the taste of potato chips treated with 1, 2, and 3% NaCl did decreased with increasing level of the salt. In current study, the result recorded from 2% NaCl was lower than 1%NaCl that is in agreement with this previous work. This author has also addressed that the taste results for samples treated with 0.5, 1, and 2% citric acid solutions did not preferred by panelists. However, in this current research, this problem was overcome by dipping all the samples in normal water after soaking to reduce the concentration on the surfaces of the slices.

In aroma, the recorded highest value was from 1% NaCl with no significant difference between 2% of NaCl, sugar, and $CaCl_2$ solutions. However, it was statistically differed from treatments with 1 and 2% citric acid and control solutions. Abou-Zaid (2015) has indicated that the sensory result for 0.5% citric acid and its mixture with NaCl have recorded the highest results in aroma. In contrast with the finding of the above author, the result of aroma recorded from 2% citric acid solution treatment was lower than other treatments. This may be the extraction of few aromatic components caused by the acid in the juice. The whiter color observed from this treatment may be indicator for this. The result from samples blanched in NaCl solution had significantly the highest scores of odor while those blanched in citric acid had significantly the lowest values (Ismial *et al.,* 2013). This work is line with current result that 1% NaCl increased the aroma (odor) whereas addition of citric acid (lemon juice) has significantly decreased it.

Crispiness (texture) is the most considered quality expected from French fries. The highest result was that of 2% NaCl (4.70). It was statistically differed from only the control treatment (4.00). This increased crispiness may come from the reduction of water from the slices caused by the concentrated solutions surrounding the slices. As seen from the weight difference of test results in this study, the weights of slices after soaking were lowered especially for NaCl and $CaCl_2$ solutions. Abou-Zaid (2015) has indicated that panelists preferred crispiness of potato chips treated with 1% NaCl, 0.5% citric_acid to citric_acid, and NaCl both at 2 and 3% of treatments.

The current result of sensory test has shown that all treatments improved the crispiness of the potato French fries when compared with the result recorded from the control sample. The samples treated in NaCl had highest scores of texture while those blanched in citric acid had significantly the lowest values.This work was in contradict with the

current result in which soaking in citric acid solutions have improved the texture (crispiness) of the potato French fries. However, the results from moisture contents test showed that citric acid solutions did not reduce moisture contents of the slices.

The highest value for overall acceptability was scored by 1% NaCl (4.52) whereas the lowest values were that of the control (4.10) and 2%$CaCl_2$ (4.00). Abou-Zaid (2015) has reported that the preference of treatment with 1 and 3% NaCl were higher than that 0.5, 1, and 2% of citric acid solutions. In the current study, French fries treated with 1%NaCl solution was more preferred than all other treatments with no significant difference among them except 2%$CaCl_2$ and control samples. According to the report of Ismial *et al.,* (2013), the slices blanched in NaCl solutions were statistically highest while the treatments with citric acid solutions were lowest. This report was in agreement with the current result in which soaking in NaCl solution has improved the overall acceptability of the French Fries.

4. Conclusion and Recommendation

Browning can be reduced by some pre-treatments such as reducing the pH and adding preservative chemicals. This study was conducted to evaluate the effects of pretreatment on organoleptic quality and oil absorption of French fries. Different chemicals (NaCl, $CaCl_2$, sugar, and citric juice) were used for pretreatments. The samples treated with NaCl, and $CaCl_2$ solutions were statistically reduced the moisture content and weight of the slices. The total soluble solids of all treatments were slightly increased showing removal contents from the slices to the solutions during soaking. The treatment with NaCl and $CaCl_2$ has increased crispiness without affecting other qualities while it reduces oil uptake of the French fries. Because, NaCl and $CaCl_2$ is advisable to reduce oil absorption capacity of the sliced potato during frying.

5. Referenes

Abbasi KS, Masud T, Gulfraz M, Ali S, Imran M (2011). Physico-chemical, functional and processing attributes of some potato varieties grown in Pakistan. African J. of Biotechnology, 10(84):19570-19579.

Abou-Zaid FO (2015). The Effect of Using Some Treatments on Reduction of Acrylamide Formation in Processed Potatoes. J. of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT), 9(11), 46-53.

Aguilera JM, Gloria-Herna´ndez H (2000). Oil absorption during frying of frozen par-fried potatoes. J. of Food Science, 65: 446–1479.

Ankur M, Arya, Chandra S, Samsher, Singh J, Chauhan N, Kumar T, Kumar K, and Prince (2017). Moisture loss and oil uptake kinetics in French-fries (var. Kufri Pukhraj) during frying in different oils and treatments. Chemical Science Review, 6(24): 2144-2148.

AACC (1986).American Association of Cereal Chemists

Annese M, Manzano M, Nicoli MC (1997). Quality of minimally processed apple slices using different modi-fied atmosphere conditions. Journal of Food Quality, 20: 359-370.

Aschemann-Witzel J, Hamm U (2010). Do consumers prefer foods with nutrition and health claims? Results of a purchase simulation. Journal of Marketing Communication 16:47–58.

Bavaneethan, Y. (2018). Department of Food Technology SLGTI. Sri Lanka.5/4/2018 Y.

Bunger A, Moyano P, Rioseco V (2003). NaCl soaking treatment for improving the quality of French-fried potatoes. Food Research International, 36:161–166

Catherine O. Chardonnet, Carl E, Sams, William S, Conway,John R, Mount, and Frances A, Draughon (2001). Osmotic Dehydration of Apple Slices Using a Sucrose/CaCl2 Combination to Control Spoilage Caused by Botrytis cinerea, Colletotrichum acutatum, and Penicillium expansum. J. of Food Protection, 64(9):1425–1429.

Cristina K, Lima MD, Barros HF, Passos ThS, (2019). The effect of using different oils and paper towel in vegetable oil absorption of fried recipes. J. of culinary science and Technology. 17 (4)

El-Bassiony KR, Afifi SA, Khalaf HH, Sharoba AM, El-Desouky AI, (2015). Effect of some pre-treatments on acrylamide concentration in potato chips Annals of Agricultural. Sciences., Moshtohor, 53(2) 211–220

Espin JC, Ochoa M, Tudela J, and Garcia Canovas F (1997). Monophenolase activity of strawberry polyphenol oxidase. Phytochem. 45: 667–670.

GarmakhanyD, Mirzaei HO, Maghsudlo YM, Kashaninejad M, and Jafari SM (2014). Production of low fat french-fries with single and multi-layer hydrocolloid coatings. J. of Food Science and Technology. 51(7): 1334–1341.

Ismial SA-M, Ali FM, Askar M, and Samy WM (2013). Impact of Pre-Treatments on the Acrylamide Formation and Organoleptic Evolution of Fried Potato Chips. American J. of Biochemistry and Biotechnology, 9 (2): 90-101

Kalyani Y, Gaikwad KA. Athmaselvi G, Sarathchandra (2016). Acrylamide in Potato Chips, Its Formation, Reduction and Identification: A Review: International Research J. of Engineering and Technology, 3 (04).

Kita A, Lisińska G, Gołubowska G. (2007). The effects of oils and frying temperatures on the texture and fat content of potato crisps. Food Chemistry, 102:1–5.

Krokida MK, Oreopoulou V, Maroulis ZB, Marinos-Kouris D (2001). Effect of osmotic dehydration pretreatment on quality of French fries. J. of Food Engineering, 49(4), 339-345.

Li Shua, Obagbemib IJ, Liyanaarachchia S, Navaratnac D, Parthasarathya R, Ben Aimd R, Jegatheesan V (2016). Why does pH increase with CaCl2as draw solutionduring forward osmosis filtration. Process Safety and Environmental Protection, 104: 465–471

Magda S, sharra M, Ghoneim (2015).Evaluation of five potato varieties for producing French fries. African journal of food science, Alex J. of food science and Technology, 12(2), 1-9

Mestdagh F, De Wilde T, Delporte K, Peteghem CV, Meulenaer B (2007). Impact of chemical pre-treatments on the acrylamide formation and sensorial quality of potato crisps. Food Chemistry, 106 (2008): 914–922

Mestdagh F, de Wilde T, Fraselle S, Govaert Y, Ooghe W, Degroodt JM, Verhe R, van Peteghem C, de Meulenaer B(2008). Optimization of the blanching process to reduce acrylamide in fried potatoes. LWT Food Science Technology, 41(9):1648–1654.

Mirzaei HO, Garoumi H, Salehi F, Farhadpour F. (2015) Effect of Ratio Oil to Potato on Amount of Oil uptake and Quality of Potato French Fries. MOJ Food Process Technology Processing Technology, 1(1): 00005. DOI: 10.15406/mojfpt.2015.01.00005.

Mokhtar, W MGhawi SK, and Niranjan K (2019). Dehydration of potato slices following brief dipping in osmotic solutions: effect of conditions and understanding the mechanism of water loss. Drying Technology, 37 (7):885 - 895.

Moreira RG, Castell-Pérez ME, Barrufet MA (1999). Deep Fat Frying: Fundamentals and Applications. An Aspen Publication, Aspen Publishers, Inc., Gaithersburg, Maryland. USA, pp. 3-74.

Moyano PC, Rioseco VK, Gonzalez PA (2002). Kinetics of crust color changes during deep-fat frying of impregnated French fries. J. of Food Engineering, 54:249–255.

Oms-Oliu G, Rojas-Grau MA, González LA, Varela, P, Soliva-Fortuny R, Hernando MI, Munuera IP, Fiszman S, Martin-Belloso O (2010). Recent approaches using chemical treatments to preserve quality of fresh-cut fruit: A review. Postharvest Biol. Technol. 57:139–148.

Parikh, Anish A, and Nelson, Douglas C (2013). "Fat Absorption in Commercial French Fries Depending on Oil Type and Coating,"Hospitality Review: 30(2), Article 1.

Pedreschi F (2012). Frying of potatoes: physical, chemical, and microstructural changes. Dry Technology, (30):707–725.

Porkony, J, (1999). Flavor chemistry of deep fat frying in oils. In Smouse, T. & Perkins, E. G. (Ed.) Flavor Chemistry of Lipid Foods, American Oil Chemists Society: Illinois. Potato chips. Plant Foods for Human Nutrition 41, 291-297.

Rosen J, Hellena¨s KE (2002). Analysis of acrylamide in cookedfoods by liquid chromatography tandem mass spectrometry. Analyst, 127: 880–882

Sayon-Orea C, Martinez-Gonzalez MA, Gea A, Flores-Gomez E, Basterra-Gortari FJ, Bes-Rastrollo M.(2014). Consumption of fried foods and risk of metabolic syndrome: the SUN cohort study. Clinical Nutrition, 33:545–549

Silayo, VCK, Laswai HS, Mkuchu J,and Mpagalile JJ (2003). Effect of sun-drying on some quality characteristics of sweet potato chips. African. J. of Food Agriculture. Nutrition. Dev., Vol (3)

Sindhu R, Khatkar BS (2018). Effects of Chemical Treatments on StorageStability of Lemon (Citrus Limon). Juice. International Advanced Research J. in Science, Engineering and Technology, 5(2): 2393-8021

Teferi D, Geremew Ch (2019). Effect of Blanching and Frying Time on the Sensory Quality of Fried Sweet Potato Chips. Food and Nutrition Science-An International J., 3(1): 2367-9018

Tran M and Chen X D, (2013). Improving the Physical Properties Crunchiness of Potato Crisps by Pretreatment Techniques and Vacuum Frying. Proceedings of SPIE - The International Society for Optical Engineering. Vol. 8793, 879307-1

Walker JR (1997). Enzymic browning in foods:its chemistry and control. Food Technology, 31:19–27

Whitaker JR, Lee CY (1995). Recent advances in chem-istry of enzymatic browning. An overview. In: Lee, C.Y.,Whitaker, J.R., editors. Enzymatic browning and its prevention. Washington, DC: American chemical society. p 2-7.

Yıldız G (2019). Control of enzymatic browning in potato with calcium chloride and ascorbic acid coatings. Food and Health, 5(2): 121-127.

Yousuf B, Kumar SA (2017). Flaxseed gum in combination with lemongrass essential oil as an effective edible coating for ready-to-eat pomegranate arils. International. J. of. Biololgy.and Macromolecules. 104: 1030–1038.

Zeeshan M, Ayub Mand, and Khan A (2016).Preservation Through Osmotic Dehydration Research & Reviews: J. of Food and Dairy Technology, 4(4):2347-2359